

August 1998 Highlights of the Pulsed Power Inertial Confinement Fusion Program

Our analysis of Z Shot 297 on August 7 suggests a dynamic hohlraum temperature of ~ 180 eV may have been achieved. Other shots during the month were two with 240 Al wires surrounding a central CD₂ fiber, two dynamic hohlraum shots with a 1.6-mm-diameter germanium-doped capsule embedded in a foam cylinder, two LLNL hohlraum shots with a nested wire array, and one shot in a series to optimize the K-shell radiation from a titanium wire array in collaboration with DTRA. Z was down from August 15-30 to remove water in the oil section, which had reduced the energy delivered to the vacuum insulator stack. The HEDP Advisory Committee met August 13 to hear talks by Sandia, Livermore, and Los Alamos on shot plans for FY99 and to evaluate the shot allocation. A total of 240 Z shots have been allocated compared to the 537 shots requested.

On shot 297, 65 kJ in x rays exited the on-axis viewing aperture, and a uniform 230-eV temperature was observed across a diameter of 1.6 mm. This represents a useful dynamic hohlraum temperature for an ICF capsule of at least 180 eV. The x-ray energy and temperature measurements are based on time- and energy-resolved, on-axis x-ray pinhole images, x-ray diodes (XRDs), bolometers, and calorimeters. The shot had a solid return current can (no off-axis openings), a double nested array of tungsten wires, a 5-mm-diameter, 14-mg/cc foam cylinder within the nested array of wires, and a 2-mm-diameter viewing aperture. The increase in temperature is a result of incorporating many improvements in the target configuration that increase the stability of the z-pinch implosion and its coupling to the low-density foam.

In collaboration with Charles Rhodes' group at Univ. Illinois-Chicago through LDRD-funded research, we produced L-shell x-ray emission from solid gold targets using a 250-fs, terawatt-class ultraviolet laser with focused irradiance of 10^{18} W/cm². These x rays may have potential as a backlighter source complementary to the Beamlet/Z backlighter for the z-pinch program. The integrated yield near 10 - 14 keV (Fig. 1) exceeds 1 mJ/2 π steradians. The spectrum exhibits a predominantly asymmetrical broadband feature superimposed on the bremsstrahlung continuum and line emission that arises from excited-state transitions induced by the highly nonlinear laser interaction. As part of the experimental campaign, short (ps) x-ray bursts created by M-shell xenon (~ 1 keV) and L-shell barium fluoride (4 - 5 keV) targets were used to measure the impulse response of XRDs and photoconductive detectors. The measured fast (100-ps) rise time of both instruments indicates that these x-ray diagnostics can be used to study hydrodynamic evolution of z pinches.

New radiation magnetohydrodynamic algorithms for ALEGRA have been developed that are compatible with the arbitrary Lagrangian Eulerian nature of the code, which allows the material and the mesh to move independently. We have simulated a LANL imploding Al foil experiment done on Pegasus with 2D ALEGRA and compared these results with the 2D Eulerian LANL code (Fig. 2). The early-time growth of the instability of a z-pinch sheath has also been simulated with 3D ALEGRA on the massively-parallel Sandia/Intel teraflops computer.

Recent velocity interferometer experiments on Z using a small secondary hohlraum filled with low-density plastic foam indicate that relatively flat pressure profiles can be obtained in aluminum samples for times of about 24 ns. The implication is that equation-of-state (EOS) samples can be as thick as 700 μ m (vs. the 100 μ m used now), resulting in substantially improved accuracy of the data. In the next series of EOS shots larger secondaries, which are not influenced as much by 2D effects, will be used to confirm these results.

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Fig. 1. X-ray emission from Au foil excited by 250-fs, 240-mJ excimer laser.

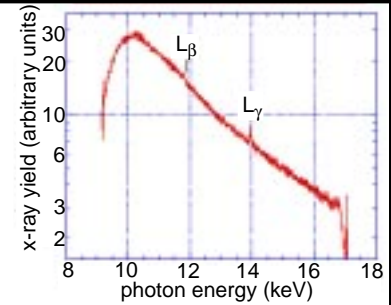


Fig. 2. 2D simulations of imploding foil showing

isodensity contours at 240 ns. Magnetic flux penetrates plasma at bubble; plasma is left behind at spike location.

